Resuspension of Contaminated Sediment during Cap Placement
Subtask 3.2.1.

Introduction

During cap placement, resuspension, volatilization, or other movement of chemical contaminants can occur. There are no standardized methods to predict the degree of contaminated sediment resuspension and release of contaminants into the dissolved phase resulting from cap placement. This memorandum summarizes the limited field data on the extent of resuspension of sediment during cap placement based on a review of the literature. The results of this evaluation will be used to develop resuspension performance standard during cap placement, such as maximum allowable rates of resuspension, total suspended solids (TSS) and contaminants of concern (COCs) concentrations. The goal of the performance standard for loss prevention during cap placement is to limit upriver and downriver migration of COCs and clean cap materials from the capping operations in the lower 8.3 miles to the upper nine miles and to Newark Bay and the New York-New Jersey Harbor Estuary.

Measures to reduce resuspension, volatilization, or other contaminant movement should include selection of cap materials, placement equipment, and placement methods. Currently available technology and techniques are described below.

Selection of Cap Placement Method

Three major placement techniques, conventional placement (Hopper dredge, pipeline and barge), spreading methods and submerged discharges, have been used to place cap material on soft sediments similar to those in the Lower Passaic River. The selection of the placement approach should provide reasonable controls for resuspension, and should depend on geotechnical properties of contaminated sediments, thickness of the cap, water depth, hydrodynamics, and slopes. Resuspension can be controlled by the rate and method of placement and using containment measures (silt curtains, sheet piles, etc.) (USEPA, 2005; Palermo et al., 1998). At the Boston Harbor site (Lyons et al., 2006), the cap material was distributed over the cells using a partially opened hopper dredge that was maneuvered laterally over each cell by a tugboat. At the Eagle Harbor site (Lyons et al., 2006), capping was performed by transporting quarry sand to the site in a flat topped barge and using a high pressure hose to wash the sand overboard while maneuvering the barge with a tugboat to gradually produce a uniform cap.

At the Palos Verdes Shelf (PVS) site (Fredette et al., 2002), the cap was placed by fully opening the hopper dredge doors at predetermined discrete locations (conventional point placements) or partially opening the hopper dredge doors along a linear track line (spreading methods) or by pump out through the hopper drag arm.

At Pacific Sound Resources Superfund site (Dunn et al., 2005), a variety of cap placement methods were used, including skiff box capping, excavator capping, backhoe capping, stern of barge capping, and bottom dump barge capping. Skiff box capping was performed by lowering the skiff box to within 3 feet of the mudline, opening the flaps on the box, and releasing the cap material. Excavator capping was

performed by scooping the cap material from a barge into the bucket, moving the bucket arm over the water, and releasing the capping material at the water surface. Backhoe capping was performed by transferring the cap material from a barge to shore using a conveyor belt and distributing the material on the shore during low tide, in the dry, with a backhoe. Stern of barge capping was performed by pushing the cap material over the stern of barge. Bottom dump barge capping was performed by releasing the cap material about 7 feet below the water surface. These projects illustrate the range of possible approaches that have been successfully used to place caps in a gradual manner to minimize potential for resuspension and displacement of contaminated sediments.

Summary of Observations of Sediment Resuspension and Release of Contaminants during Cap Placement

Studies have been conducted to characterize the sediment resuspension and contaminant release due to capping-related activities. Most of the studies only employed the monitoring of water quality parameters, including total suspended solids (TSS), dissolved oxygen (DO) and turbidity, at locations immediately adjacent to the capping area or within the boundary area. A few studies included the collection of total water column samples and the chemical analysis of site-specific COCs. Table 1 summarizes the limited field data from the following sites: Boston Harbor in Massachusetts, Eagle Harbor in Washington, Palos Verdes Shelf (PVS) in California, and Pacific Sound Resources in Washington.

USEPA measured the resuspension of PAHs and/or PCBs during capping events at the Boston Harbor site and Eagle Harbor Superfund site (Lyons et al., 2006). The water samples were collected at approximately 1 to 2 m above the sediment surface within the capping area. The baseline concentrations of PAHs and PCBs were approximately 50 ng/L and non-detect, respectively. The maximum reported concentrations of total PAHs and total PCBs during capping were 5,242 ng/L and 84 ng/L, respectively. On average, the concentrations of total PAHs (dissolved plus suspended) in the water column showed a 10 to 30-fold increase from the baseline concentration after the placement of the first capping layer and a 1 to 3-fold increase immediately after placement of the second capping layer. The PAH concentration decreased to approximately one tenth of its maximum concentration after 1 hour of capping. Similar to PAHs, the concentrations of PCBs showed an approximately 40-fold increase from the baseline concentration immediately after the placement of the first capping layer and a 4-fold increase immediately after placement of the second capping layer. The concentration of PCBs decreased to approximately one fourth of its maximum concentration after 1 hour of capping.

US Army Corps of Engineers (USACE) conducted a large-scale capping field pilot study at the Superfund PVS site as part of its technical support for the continued evaluation of in situ capping (Fredette et al., 2002). Water samples were collected in the centroid area and near bottom portion of the water column. TSS levels in the centroid of the near-bottom plume decreased to baseline levels within 2 hours. The concentrations of total DDE (dissolved plus suspended) were greatest at the inception of the plume (100-1200 ng/L) and decreased within 1-2 hours to below baseline levels (6-20 ng/L). The highest DDE concentrations were also observed during the first placement event to occur in the cells, whereas subsequent placement events began with much lower DDE concentrations.

The release of DDE was related to the cap replacement methods and its concentrations in sediment. For two capping cells LU and LD with similar sediment DDE concentrations, near-bottom TSS and DDE concentrations from the conventional placement operations in Cell LU were about 3 and 4 times higher than those from the spreading placement in Cell LD. For the same conventional placement method, the peak DDE concentrations in Cell SU were approximately 4-fold higher than those in Cell LU, consistent with the several-fold higher DDE concentrations in surface sediments measured in Cell SU compared to Cell LU. Based on the bottom surge speed and turbidity data, the resuspension of sediment caused by capping was limited to an area within 100 m upslope and 200 m downslope of the placement site. The study also reported that physical disturbance to the sediment was limited to a few centimeters for initial placements of cap material, and disturbance was minimized by overlap of successive cap placement locations.

Dunn et al. reported the sediment resuspension and its effects on water quality during the capping of PAH/PCB-contaminated sediments at the Pacific Sound Resources Superfund site during 2003/2004 and 2004/2005. Surface water monitoring for turbidity, TSS, DO and temperature found no violations of water quality criteria at boundary locations, which were about 600 feet from the capping area. This project did not report the concentrations of PAHs/PCBs in the water column.

Overall, the above studies demonstrated that the increase of contaminant concentrations (i.e., both suspended and dissolved concentrations of PAH, PCB, DDE) in the water column within the capping cells were the greatest after placement of the first capping layer, and the magnitude decreased with placement of successive capping layers. The water column concentrations within the capping cells generally decreased to baseline levels within 2 hours. Although the measurements of turbidity indicated that the resuspension was limited to approximately 600 feet from the capping cell, contaminant concentrations in waters outside of the capping cells were not available to evaluate the spatial impact from the release of contaminants during cap replacement.

Conclusions

The above data indicated that the peak concentrations of PAHs/PCBs/DDE in the centroid area and near bottom portion of the water column can be up to 50-fold higher than their baseline concentrations during capping, but generally decreased to baseline concentrations within 2 hours. Although the spatial extent of the contaminant plumes was not accurately determined, their concentrations in waters outside of the plume centroid are expected to be much lower than peak levels.

The release of contaminants from suspended sediments was reported to be related to the nature of the sediments, their concentrations in sediments as well as the placement methods. The data also indicated that the most significant releases occurred with the first capping layer, and the magnitude of contaminant resuspension decreased with successive capping layers. The findings indicated that resuspension during capping may be minimized by placing the cap material in lifts, where the first lift provides a uniform layer of clean material using techniques that minimize sediment disturbance; subsequent lifts can be placed more aggressively once contaminated sediment is covered.

The overall results from these studies indicated that levels of sediment resuspension due to well-managed capping operations were acceptable. Nevertheless, a site-specific monitoring plan should be developed to evaluate the potential short-term risk to the community, workers, or environment during cap placement. The monitoring plan should incorporate high resolution in situ data collection with discrete sample collections within and outside the capping cells. The high resolution in situ measurements should include turbidity, conductivity, DO, GPS location, water depth, current speed and direction, etc. The discrete water samples should be submitted for laboratory analysis of TSS and COCs.

Key Literature

The following peer reviewed articles and project reports are key references used in this summary.

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